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# (12) EUROPEAN PATENT APPLICATION

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## (54) A connector and a method of manufacturing a plurality of contact terminals.

(57) A method of manufacturing produces a plurality of contact terminals (26) in a continuous, uninterrupted strip form. The method comprises the steps of: stamping a contact electrical terminal (26) from conductive material having certain desired spring characteristics, so that the contact terminal (26) has a spring end (30) and a crimp end (38) having a crimp opening (42) therein, crimping the contact terminal crimp end (38) onto a continuous length of electrically insulating material (66), and repeating the above steps until a plurality of spaced apart contact terminals (26) is provided in a continuous, uninterrupted strip.

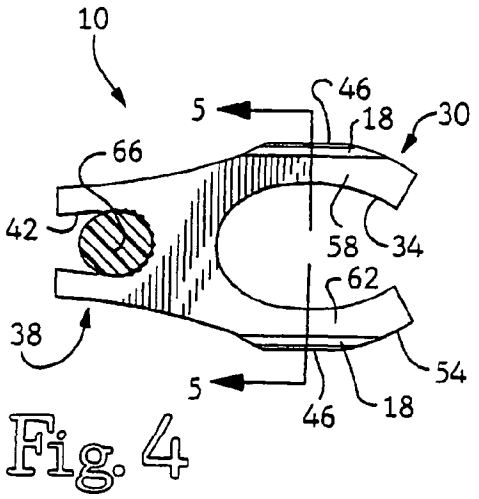


Fig. 4

EP 0 384 438 A1

# A CONNECTOR AND A METHOD OF MANUFACTURING A PLURALITY OF CONTACT TERMINALS

The invention relates to an electrical connector and a method of producing the same. More particularly, the electrical connector has a strip of electrical terminals which has at least one strip of uninterrupted insulation material attached thereto. The insulation material precisely maintains the terminals in the proper spaced relationship such that the strip of insulation material can act as a carrier strip.

It has been the practice in the prior art to stamp and form electrical contacts or terminals from a continuous strip of metal. The contacts at first were individually assembled to a printed circuit board and then soldered in place. The disadvantage of such a technique involved a requirement for hand labor to sort the contacts from one another, to assemble the contacts in desired alignment within the board, and to straighten the contacts in their final desired positions after soldering the contacts in place. Because hand labor is costly, there has been considerable effort directed toward reducing the amount of hand labor required for assembly of contacts to a printed circuit board. One of the first improvements to result from such effort resided in locating the terminals serially along a common carrier strip which was formed integral with the terminals during the stamping and forming process. This permitted the carrier strip to be fed into an insertion machine which individually severed a terminal from the strip and forcibly inserted it into a printed circuit board. The prior art further evolved into a technique whereby a plurality of electrical terminals along a common carrier strip were located within a cob-type tool which aligned the plurality of terminals for simultaneous insertion within corresponding locations in a circuit board. Using this technique, insertion of a larger number of terminals were simultaneously inserted, the common carrier strip served to align the terminals while the terminals were soldered in place within the printed circuit board. Subsequently, the carrier strip was removed from the terminals, leaving the terminals individually located within the printed circuit board.

Another version of the above techniques is described in U.S. Pat. No. 3,618,207 wherein a plurality of terminals, which extend transversely from a common carrier strip, has a body of insulating material molded transversely across the contacts. This molding is done using an intermittent molding process which provides individual housings.

Another prior art connector is the AMPLIFLEX Surface-To-Surface Connector sold by AMP Incorporated. The AMPLIFLEX connector is a thin flexible polyimide film on which individual parallel lines of etched copper circuitry plated with gold over nickel is wrapped around a soft, non-conducting silicone rubber core. The core is formulated to resist permanent set under long term compression. When the connector is compressed between two flat planes, the plated circuit lines interconnect circuit pads on each plane. The resiliency of the connector core accommodates irregular and warped surfaces.

U.S. Pat. No. 4,245,876 discloses a continuous strip of electrical terminals which is formed by stamping rectangular openings in a strip of metal. A strip of dielectric material is then adhered to the metal strips, after which the metal strips are formed into electrical terminals of a selected configuration. Discrete lengths of the formed terminals in strip form are held together as separate terminals via the dielectric material which can be severed from the continuous strip for specified uses.

U.S. Pat. No. 4,769,908 discloses a method of producing a plurality of identical electrical terminals from a metal strip having the desired spring and conductive characteristics. At least one row of rectangular openings is stamped in the metal strip. The rectangular openings are positioned such that the longitudinal axis of the openings are essentially perpendicular to the longitudinal axis of the metal strip. After the openings have been stamped, a web of insulation material is molded onto the strip of metal in alignment with each row of openings.

Disclosed is a method of manufacturing a plurality of contact terminals in a continuous, uninterrupted strip form. The method comprises the steps of: stamping a contact electrical terminal from conductive material having certain desired spring characteristics, so that the contact terminal has a spring end and a crimp end having a crimp opening therein, crimping the contact terminal crimp end onto a continuous length of electrically insulating material, and repeating the above steps until a plurality of spaced apart contact terminals is provided in a continuous, uninterrupted strip.

In one embodiment, the opening in the crimp end is open in a direction opposite the spring end, and the conductive material is in the form of a flat metal wire.

In one embodiment, the method further includes the step of applying an electrically insulating material to at least one side of the flat wire prior to stamping the contact terminals from the wire. The contact terminals are then crimped onto

the strip of insulating material so that the layer of insulating material is between each of the terminal's conductive material.

In one embodiment, the spring end is formed by stamping an opening open in a direction opposite the crimp end opening, and the crimp end is formed by stamping the outer edges of the contact crimp end to thereby reduce its outer dimensions. The method further includes the step of plating the outer edges of the metal wire, prior to stamping the contact terminal from the flat wire, with a conductive material more conductive than the flat wire metal.

Also disclosed is an electrical connector comprising an electrically insulating carrier strip, and a plurality of adjacent contact terminals, each of the contact terminals being crimped on the carrier in a spaced apart fashion to form a continuous, uninterrupted contact strip.

An object of the present invention is to provide a method for producing a plurality of electrical terminals which can be produced in a continuous, uninterrupted strip form, and which can be cut to any length desired.

A further object of the present invention is to provide a strip of insulation material which will maintain the proper spacing of the terminals, as discussed, such that the insulation material will function as the carrier strip.

Another object of the present invention is to provide a method of manufacture which can be done at a constant high rate of speed, using a minimal amount of steps to produce the plurality of terminals. The present invention can produce a plurality of terminals at speeds comparable to those with the U.S. Pat. No. 4,245,876 method, but with less production steps.

Another object of the present invention is to utilize technology known and used in the production of zippers in order to produce an electrical contact.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 is an enlarged front view of a flat metal wire with outer edges plated with a more electrically conductive metal, and with a layer of insulating material.

FIGURE 2 is a side view of the flat wire shown in Figure 1.

FIGURE 3 is a view of the flat metal wire shown in Figure 1, after having been stamped to form a contact terminal.

FIGURE 4 is an enlarged view of a plurality of the contact terminals shown in Figure 3, crimped onto a strip of electrically insulating material.

FIGURE 5 is an enlarged cross sectional view of the connector shown in Figure 4, taken along the line 5-5 in Figure 4.

FIGURE 6 is a side view of the connector shown in Figure 4.

FIGURE 7 is a view of the connector similar to Figure 4, only with the connector positioned between circuit pads on generally parallel printed circuit boards.

FIGURE 8 is a side view of the connector between circuit boards, as shown in Figure 7, showing the spring end of the terminals compensating for warpage in the printed circuit boards.

In the zipper manufacturing industry, a machine, such as the zipper chain machine sold by the Murko Machinery Company, or the one illustrated in U.S. Perrella Patent 3,482,301, which is incorporated herein by reference, stamps pieces from a flat metal wire, then crimps them onto a strip of fabric. Two of these strips are then joined together to form a common zipper, such as the one used in garments. These machines are known to be able to stamp and crimp pieces onto a carrier strip with good spacing accuracy, accomplishing the whole process at a fairly high rate of speed (about 8 feet or about 2.5 m per minute).

Illustrated in the drawings is a method of manufacturing a plurality of contact terminals in a continuous, uninterrupted strip form. The process or method of this invention utilizes this technology known and used in the zipper manufacturing industry in a novel manner in order to make an electrical connector 10.

More particularly, the process begins with the selection of a flat wire 14 made of an electrically conductive material having desirable spring characteristics. In the preferred embodiment, BeCu is used. In this embodiment, the outer edges of the flat metal wire are plated with a conductive material 18, such as gold, which is more conductive than the flat wire metal 14, thereby increasing the overall electrical current carrying capabilities of the conductive material. In order to minimize the cost of plating, selective plating may be performed.

A suitable electrically insulating material 22 is applied to one side of the flat metal wire 14, in a sufficient thickness so as to prevent the passage of any current between adjacent terminals, when the insulating material is between the terminals, as illustrated in Figure 5. In the preferred embodiment, the insulating material 22 is a sprayed on insulating enamel, applied in a manner similar to the way paint enamel is applied to metal zippers. In other embodiments, a dielectric sheet of material, such as Mylar or Kapton, can be laminated to the side of the wire. It is important to note that the edges of the flat metal wire must not have the insulating material applied thereto.

An insulated contact terminal 26 is then stamped from the flat metal wire 14. The stamping

process, which preferably occurs in a single stroke, produces a spring end 30 formed by an opening 34 in an end of the contact terminal 26, and a crimp end 38 having a crimp opening 42 therein open in a direction opposite the spring end 30. The terminal 26 is also stamped, as illustrated in Figure 3, so that the outer edges of the contact crimp end 38 have outer dimensions which are less than the outer dimensions of the spring end outer edges 46. The spring end corners 54 are also rounded. The spring. end 30 thus comprises a generally "C" shaped member having first and second spring arms, 58 and 62, respectively. Other embodiments of contact terminal 26 are possible. In particular, crimp opening 42 can open in a direction toward the spring end 30 or in a direction which is perpendicular to the spring end 30.

After each of the contact terminals 26 is formed, as described above, the contact terminal crimp end 38 is crimped onto a continuous length of flexible electrically insulating material in the form of a cord 66, so that the terminal insulating material 22 is between each of the terminal's conductive material 14. More particularly, the crimp opening 42 has serrations which assist in the securing of the terminals 26 to the cord 66.

The above steps are then repeated until a plurality of spaced apart insulated contact terminals 26 is provided in a continuous, uninterrupted strip. This strip forms the connector 10.

The above described process of repeatedly stamping and crimping to form a continuous strip of adjacent, spaced apart contact terminals 26, utilizes a zipper chain machine, like the one described above. As a result, an electrical connector is formed, which is less expensive to manufacture than the aforementioned electrical connectors.

After the terminal strips 18 are formed, the continuous strip can be cut to accommodate any size of connector 10 required. For example, if only two terminals 26 are required, two terminals will be severed from the strip. In the alternative, the continuous plurality of terminals 26 can be stored in some fashion until needed. If storage is to occur, it is critical that the insulation material accurately maintain the positioning of the terminals over time. For storage reasons, it is important that the insulation material have some flexibility, to facilitate wrapping the strip 68 around a reel or the like.

The plurality of contact terminals 26 can be used anywhere where connection between circuit pads 70 on two parallel planes is desired. More particularly, as illustrated in FIGS. 7 and 8, the connector 10 is shown located between the circuit pads 70 of two circuit boards 74. The connector 10 is held in place by a suitable housing (not shown), similar to the way in which the contact modules are positioned between the circuit boards in U.S. Pat. No. 4,699,593, which is incorporated herein by reference.

As is shown in Figure 8, the flexibility of the strip of terminals 26 provides the means to allow the connector to adequately accommodate irregular and warped board surfaces. This flexibility insures that the terminals 26 of the connector will provide a positive electrical connection with the circuit pads 70 of the boards.

The flexibility provided in the strip is provided by the flexibility of the contact terminal spring ends 30 and the flexible insulating cord 66. The spring ends 30 are configured to allow the ends to be stressed toward each other, without the ends taking a permanent set. The resiliency of the material used to manufacture the terminal enhances these resilient characteristics. Consequently, when the terminals are positioned between circuit boards 74, the spring ends 30 of the terminal can resiliently deform to accommodate for any warpage of the boards. This resilient deformation of the terminals insures that each terminal will exert a sufficient force on the respective circuit pads 70 to maintain a positive electrical connection therebetween.

Flexible insulating cord 66 also allows the terminals to effect a positive electrical connection when the boards are irregularly shaped or warped. As was previously described, terminals 26 are crimped onto insulating cord 66. The insulating cord 66 is therefore the means which maintains the terminals in place relative to each other. Consequently, as cord 66 is flexible, terminals 26 are able to move relative to each other in a direction which is essentially perpendicular to the axis of the cord 66. This movement of the terminals allows the terminals to "float" in order to compensate for board warpage and irregular shape.

The flexibility of the connector is important to provide a positive electrical connection. In particular, the configuration of the connector allows the terminals 26 and cord 66 to adequately compensate for varied spacing between boards 74, without causing either the terminals 26 or the cord 66 to take a permanent set. Consequently, the connector described herein can be used over many cycles.

Various other features of the invention are set forth in the following claims.

## Claims

1. A method of manufacturing a plurality of contact terminals (26) in a continuous, uninterrupted strip form, the method comprising the steps of:
stamping a contact electrical terminal (26) from conductive material (14) having certain desired spring characteristics, so that the contact terminal (26) has a spring end (30) and a crimp end (38)

having a crimp opening (42) therein,
crimping the contact terminal crimp end (38) onto a continuous length of electrically insulating material (66), and
repeating the above steps until a plurality of spaced apart contact terminals (26) is provided in a continuous, uninterrupted strip.

2. A method in accordance with Claim 1 wherein the opening (42) in the crimp end (38) is open in a direction opposite the spring end (30).

3. A method in accordance with Claim 2 wherein the conductive material is in the form of a flat metal wire (14), and wherein the spring end (30) is formed by stamping an opening open (34) in a direction opposite the crimp end opening (42), and the crimp end (38) is formed by stamping the outer edges of the contact crimp end (38) to thereby reduce its outer dimensions.

4. A method in accordance with anv of claims 1 to 3 wherein the conductive material is in the form of a flat metal wire (14), and wherein the method further includes the step of applying an electrically insulating material (22) to one side of the flat wire (14) prior to stamping the contact terminals (26) from the wire (14), and wherein the contact terminals (26) are crimped onto the strip of insulating material (22) so that the layer of insulating material (22) is between each of the contact terminal's conductive material (14).

5. A method in accordance with any of claims 1 to wherein the conductive material (14) is in the form of a flat metal wire (14) and wherein said method further includes the step of plating the outer edges (46) of the metal wire (14), prior to stamping the contact terminal (26) from the flat wire (14), with a conductive material more conductive than the flat wire metal.

6. An electrical connector (10) comprising an electrically insulating carrier strip (66), and
a plurality of adjacent contact terminals (26), each of said contact terminals (26) being crimped on said carrier strip (66) spaced apart fashion to form a continuous, uninterrupted contact strip.

7. An electrical connector (10) as recited in claim 6 wherein the insulating carrier strip (66) is a cord of flexible material, such that the continuous, uninterrupted contact strip may be bent as required.

8. An electrical connector (10) as recited in claim 6 or 7 wherein the contact terminals (26) have a spring end (30) which has resilient contact arms (58,62), the resilient contact arms (58,62) cooperate with contact surfaces provided on respective printed circuit boards, such that as the electrical connector (10) is placed between two circuit boards, the resilient contact arms (58,62) are moved to a stressed position, in order to compensate for the warpage associated with the respective printed circuit boards.

9. An electrical connector (10) as recited in any of claims 6 to 8 wherein the contact terminals have electrically insulating material (22) provided on side surfaces thereof, the electrically insulating material (22) providing the spacing between the respective contact terminals (26).

10. An electrical connector (10) as recited in claim 9 wherein the free edges (46) of the contact arms (58,62) are free of insulating material.

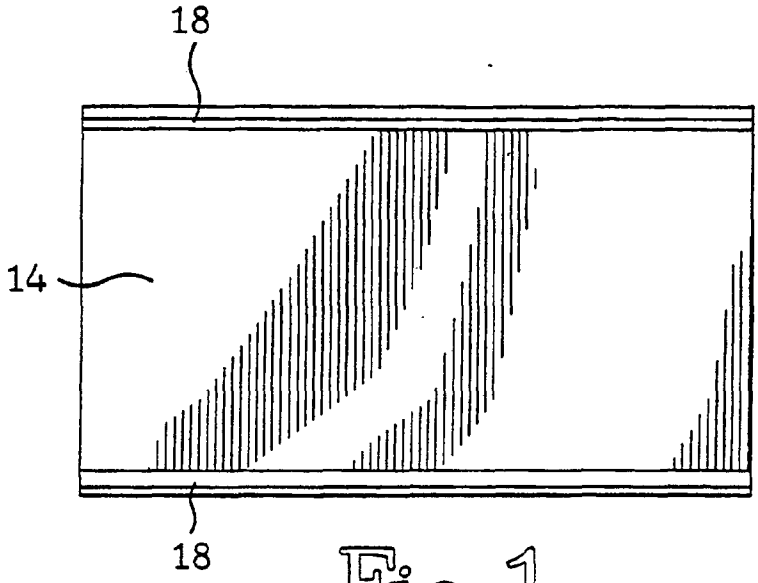


Fig. 1

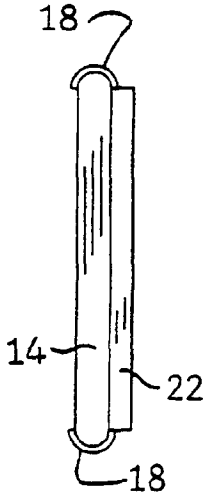


Fig. 2

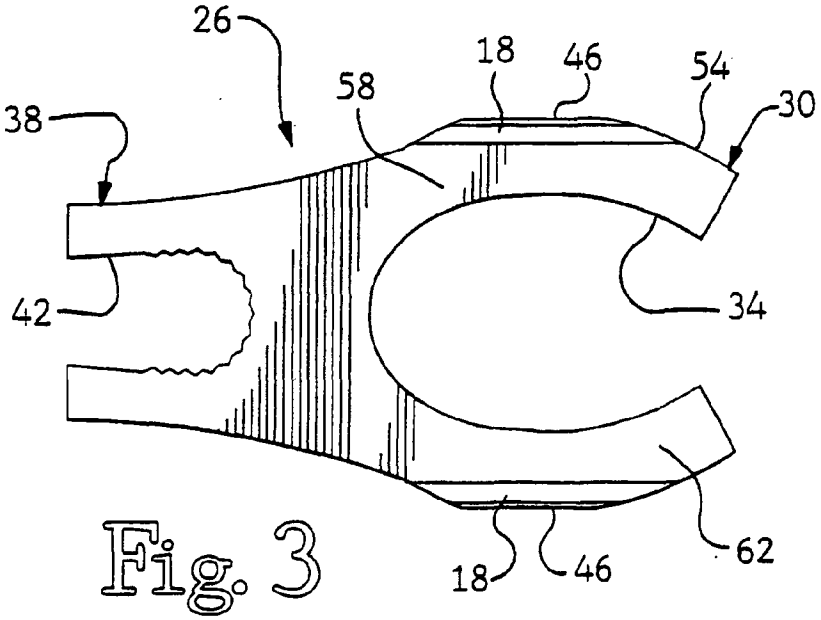


Fig. 3

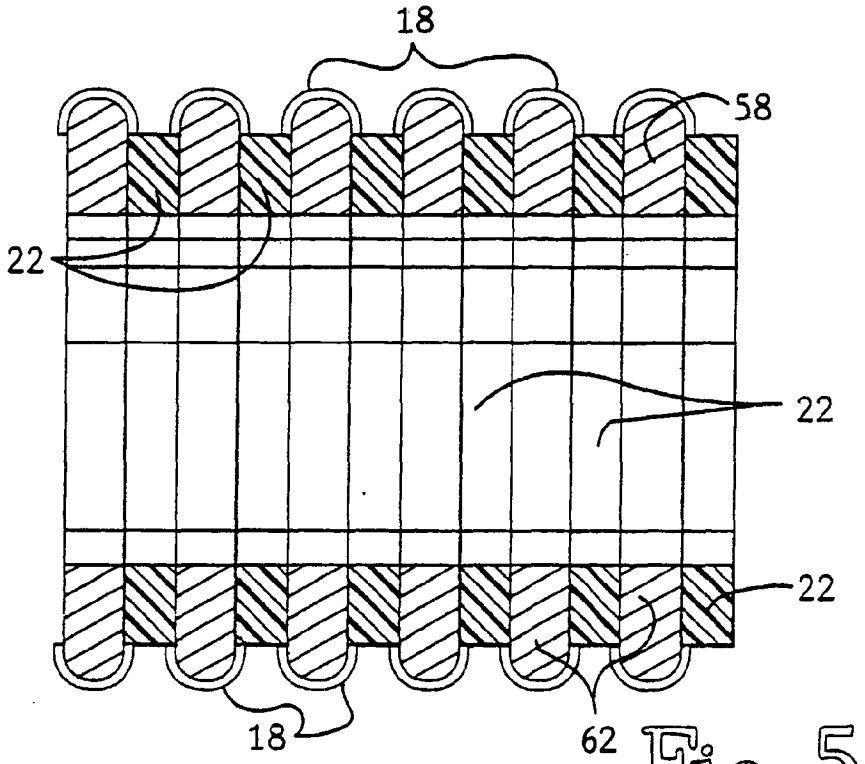


Fig. 5

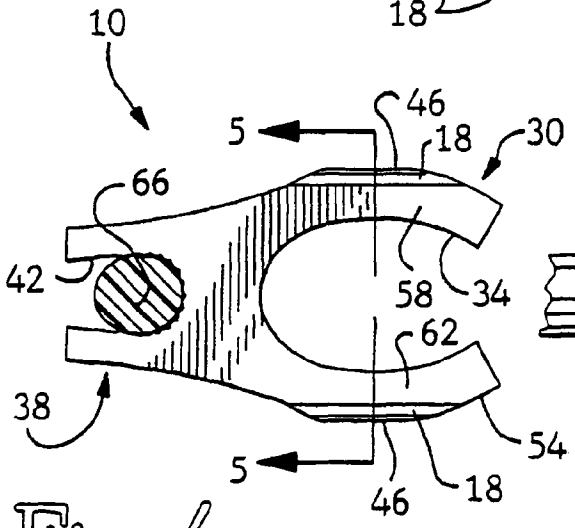


Fig. 4

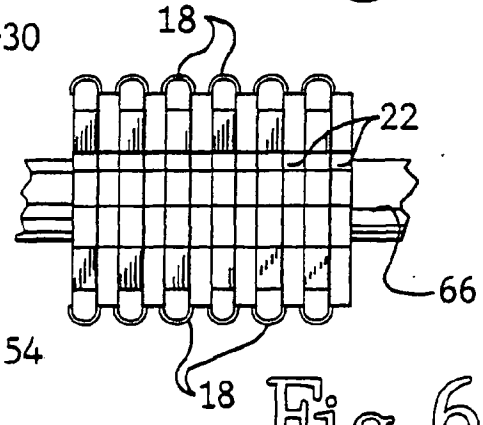


Fig. 6

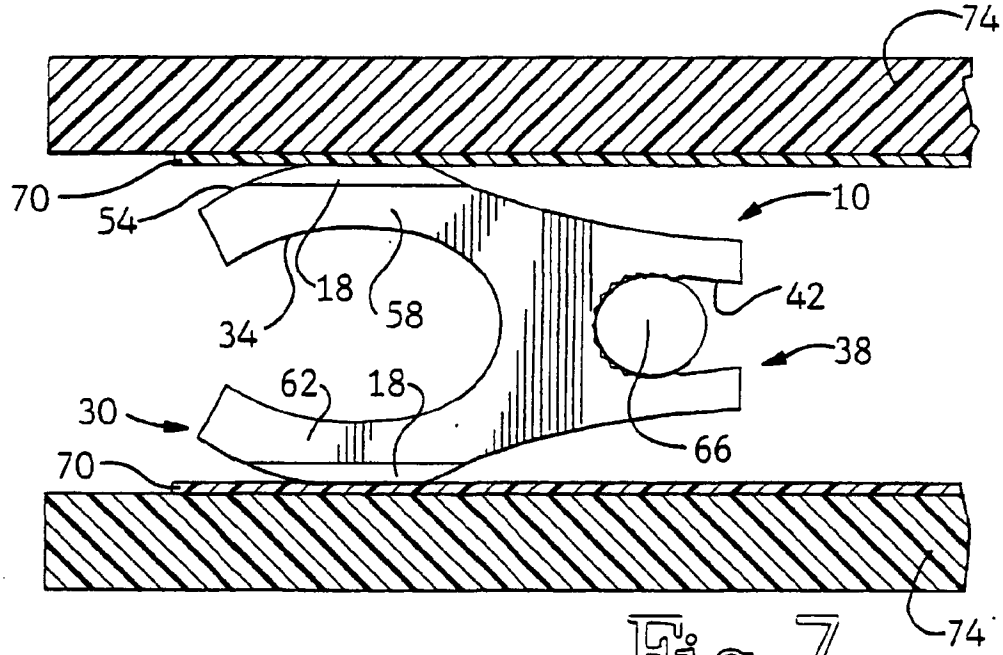
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Fig. 7

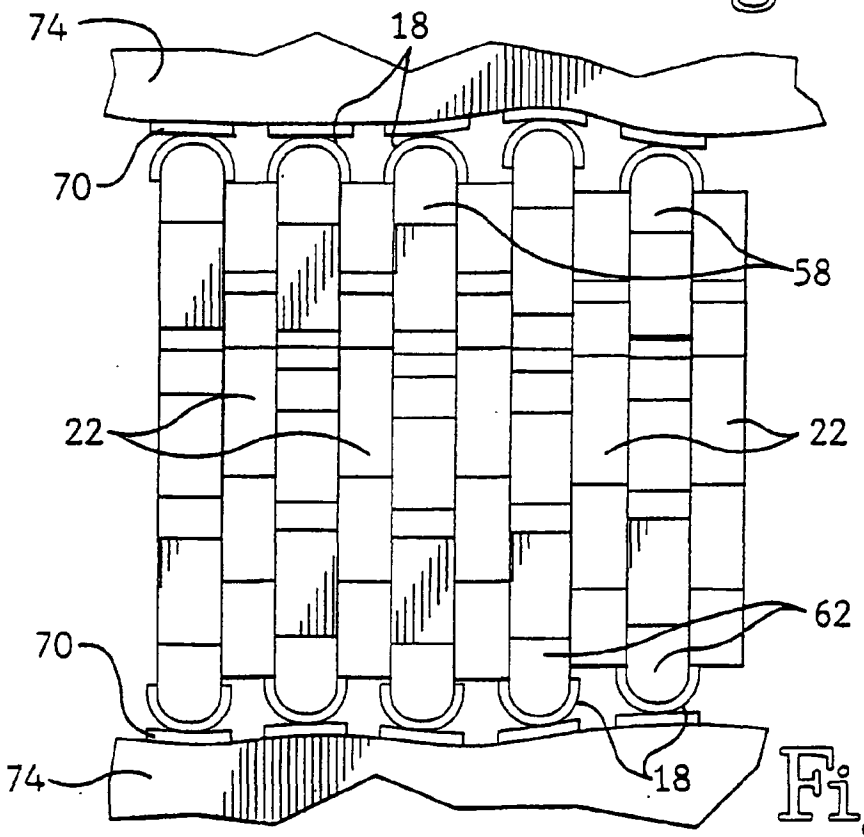
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Fig. 8

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number

EP 90 10 3355

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| A | EP-A-53968 (CII-HONEYWELL BULL)<br>* page 3, line 4 - page 4, line 24; figures 4-7 *<br>--- | 1-10 | H01R13/24<br>H01R43/16 |
| A | FR-A-1529405 (INTERNATIONAL BUSINESS MACHINES CORPORATION)<br>* page 2, right-hand column, lines 20 - 44; figure 3 *<br>--- | 1-10 | |
| A | US-A-3638163 (BELL TELEPHONE LABORATORIES)<br>* column 1, line 12 - column 2, line 10; figures 1, 6 *<br>----- | 1-10 | |
| | | | TECHNICAL FIELDS SEARCHED (Int. Cl.5)<br>H01R |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 25 MAY 1990 | CRIQUI J.J. |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

2

# PATENT SPECIFICATION

709,898

Date of Application and filing Complete Specification: Dec. 23, 1952. No. 32619/52.

Complete Specification Published: June 2, 1954.

Index at acceptance:—**Class 44,** E4E.

## COMPLETE SPECIFICATION

## Improvements in or relating to Sliding Clasp Fasteners

We, HELMUT HEIMBERGER, of 3, Eckardtsberg, Coburg, Germany, a German Citizen, and AUGUST BUNGER, of Erlenrode, Wuppertal-Nächstebreck 2, Germany, a German Citizen, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to sliding clasp fasteners of the kind having members adapted to rock transversely to the longitudinal direction of the fastener, and particularly intended to produce tight connections which are retained even when high pressures are applied.

In air- or water-tight sliding clasp fasteners produced hitherto, projecting beads lying on both sides of the middle plane of the fastener and provided on the pieces of material to be joined together were pressed against one another by tensely stressed fastening members. The fastener members of these fasteners rock in the longitudinal plane of the fastener on opening and closing. This necessarily results in the dependence of the pressure, which produces the seal, between the mutually contacting edge parts of the pieces of material, on the tensile stress producing said pressure, since the tensile stress causes an elongation, determined by their size, of the members hooked together, thus leading to an elongation and hence to a reduction of the pressure between the sealing edges bearing against one another. This drawback can be only incompletely overcome by providing an elastic initial tension, since it is obviously not possible to select any desired magnitude for the dimensions of the fastener members, because the latter must be accommodated between the sealing edges of the pieces of material to be joined together. The attainable tightness with respect to elevated pressures is accordingly only relatively slight in proportion to the external cross-sectional dimensions of the fastener.

Fasteners have moreover already been disclosed in which the fastener members rock transversely to the longitudinal direction of the fastener during the opening and closing of the latter. With such fasteners, tightness in respect of the passage of air, water, or the like, has not been achieved, since the coupling parts of the members lie between the edge parts of the pieces of material to be joined together. However, fasteners of this type have also already been proposed in which only one of the pieces of material to be joined together is provided with members adapted to rock transversely to the longitudinal direction of the fastener, said members being intended to engage like hooks over a bead edge of the other piece of material. In such fasteners, however, adequate tightness cannot be achieved, because the hook-shaped members are only rocked over the bead in order to reach the closing position, and adequate sealing pressure cannot be achieved by that means. Such fasteners have therefore not attained any practical importance.

This invention has for an object the provision of a sliding clasp fastener which, in addition to the ability to cope with forces exerted transversely to the direction of the length of the fastener, is also able to press tightly together the pieces of material to be joined, without thereby producing any substantial dependence of the tightness on the pressure to be withstood. To this end, the fastener members are so constructed that they engage like hooks over edge strips of the parts to be joined and in the engaged position can be tightened in relation to one another, being formed according to the invention by clamp arms which engage from opposite outer sides over oppositely situated edge strips projecting transversely to the surfaces of the parts to be connected and by means of a slide can be pressed against said

[Price 2/8]

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**United Kingdom**

(51) INT CL$^7$
**H01R 12/26 , A44B 19/34 , H01R 24/00**

(52) UK CL (Edition V )
**H2E** ECAGX ECBD ECX EEH
**E2S** SHX

(56) Documents Cited
**DE 020014929 U** **FR 002561452 A1**
**US 5499927 A** **US 4931021 A**

(58) Field of Search
Other: **Online: WPI, EPODOC, JAPIO**

(54) Abstract Title
**Using a zip as an electrical connector**

(57) A zip fastener is used as an electrical connector. Some of the teeth are conductive and some are insulating, allowing the connector to be multi-pole. The connector may be attached to clothing, with the wires to it woven into the fabric of the clothing or the zip. Different layouts of teeth can be used so that one connector may mate with a variety of other equipment.

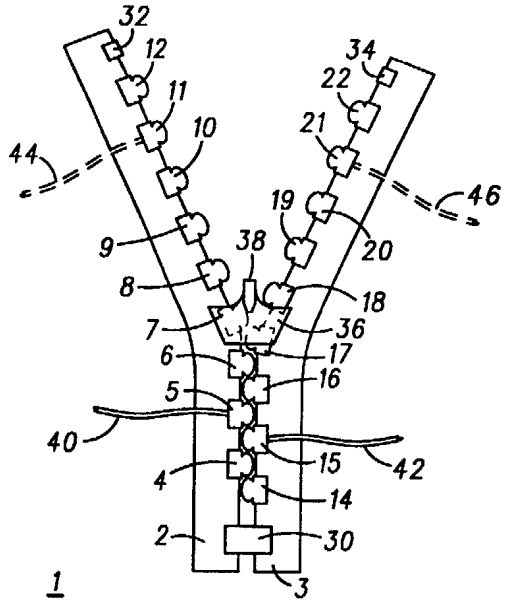


FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

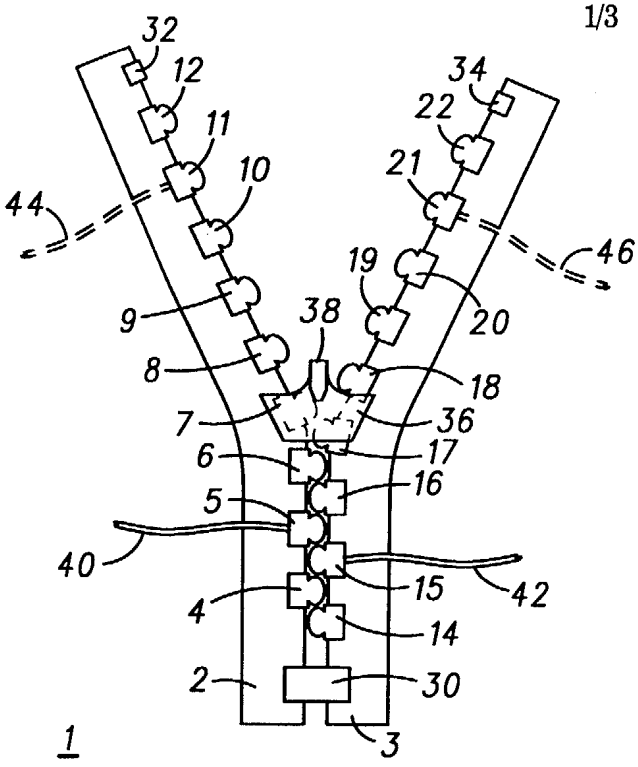
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FIG. 1

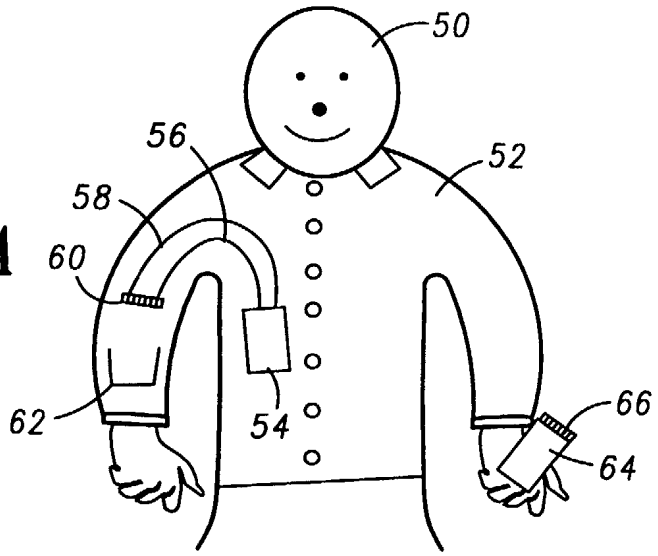
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FIG. 2A

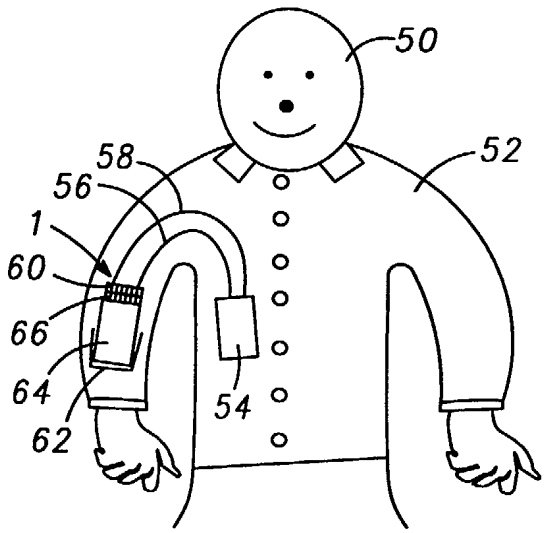


FIG. 2B

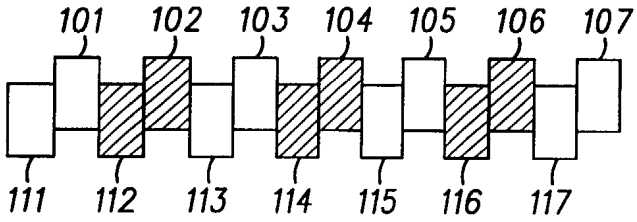


FIG. 3A

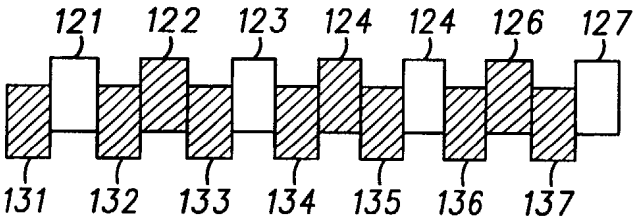


FIG. 3B

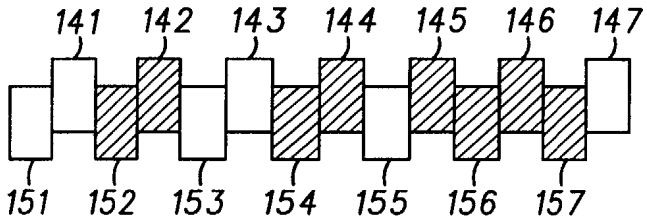


FIG. 3C

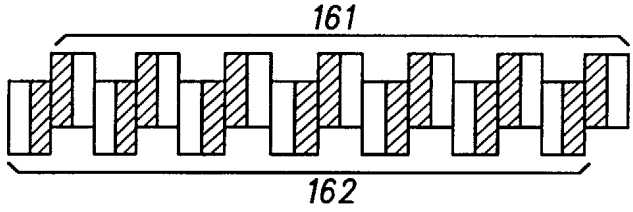


FIG. 3D

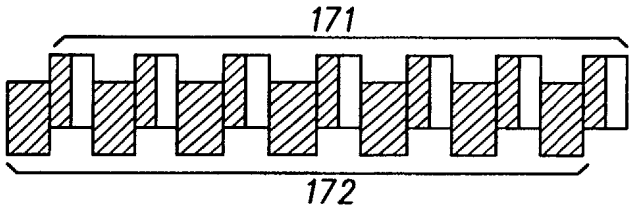


FIG. 3E

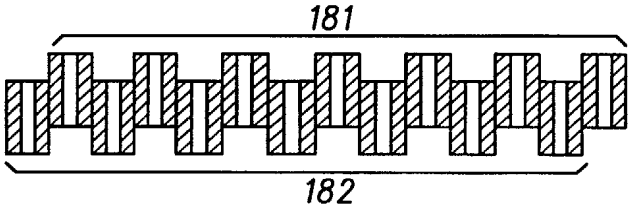


FIG. 3F

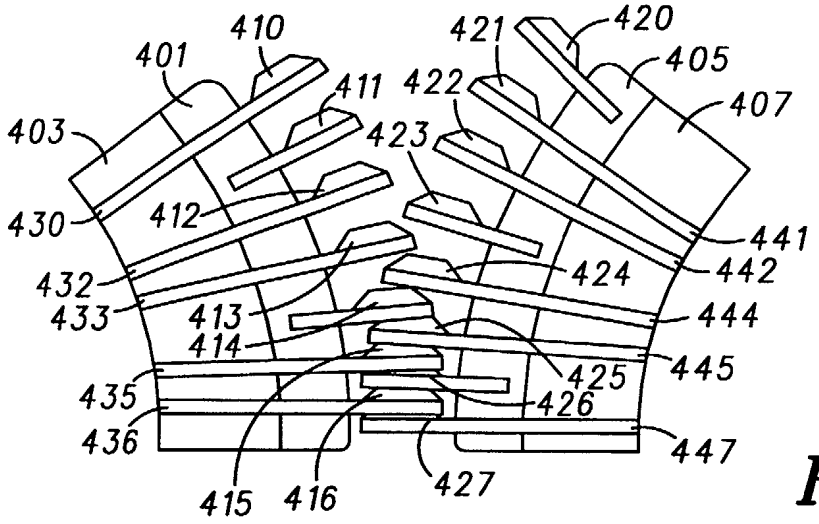


FIG. 4

# Electrical Connector

## Field of the Invention

This invention relates to providing electrical connection. The invention is applicable to, but not limited to, providing multiway connection.

## Background of the Invention

A variety of different electrical connectors are known for connecting conducting leads or wires, or other conducting elements, such as tracks on a printed circuit board. Conventional connectors are usually of the push-fit design, e.g. plug and socket. In the case of multiway connection, many pins and sockets may be connected at the same time by a push fit method, e.g. in a printer cable connection to a personal computer. Such types of connection are also conventionally used to connect two or more printed circuit boards together.

The accumulative force of pushing all the different separate connections of such connectors together is high, requiring strong mechanical properties and leading to potential breakage/wear and tear. Also, such connections frequently do not provide a fixing force, and hence often a separate mechanical fixing needs to be employed, such as screws in addition to the pin connections on a printer/personal computer connection.

A general need therefore arises for an improved and alternative type of connector and method.

It is further known that present methods of making electrical/electronic devices (e.g., radios or cellular telephones) easier to carry is to make them smaller, and to integrate functionality from several devices into one device to decrease the number of such items to be carried. However, making the devices small sometimes has adverse usability aspects and the integration of devices can limit the flexibility to tailor the function of the device to a user's precise requirements. It has therefore been proposed to incorporate electrical items in clothing.

Conventional methods of electrically connecting modules within the piece of clothing so that they may communicate with one another for both electrical power and data while retaining modularity are limited in their suitability for providing flexibility and ease of use.

It is known that 'press studs' (also known as 'snap' fasteners) are used as electrical connectors (e.g., as used on anti-static wrist bands). It has also been proposed to use suspenders as electrical connectors.

However, this approach has the disadvantage that press studs and suspenders become an impractical solution for a large number of connections.

Thus a further particular need arises for an improved electrical connection means for connecting electrical items in relation to clothing.

Unrelated to electrical connection applications, zip fasteners, also known as zippers, have been known for a very long time, the first patent for a zip fastener being granted in 1917 (US 1,219,881).

Statement of Invention

In a first aspect, the present invention provides a method of electrically connecting items, as claimed in claim 1.

In a second aspect, the present invention provides a method of connecting and fixing together printed circuit boards, as claimed in claim 6.

In a third aspect, the present invention provides a method of attaching electrical equipment to clothing and making electrical connections therefor, as claimed in claim 7.

In a fourth aspect, the present invention provides portable electrical apparatus, as claimed in claim 8.

In a fifth aspect, the present invention provides electrical apparatus, as claimed in claim 11.

In a sixth aspect, the present invention provides an electrical connector, as claimed in claim 12.

Further aspects are as claimed in the dependent claims.

The present invention uses a zip fastener, also known as a zipper, for electrical connection.

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is an illustration (not to scale) of a first embodiment of a zip fastener connector;

FIG. 2A shows a person wearing a jacket with a lightweight battery driven music player sewn into the jacket;

FIG. 2B shows a display device connected to leads of the music player of FIG. 2B by means of a zip fastener connector;

FIGS. 3A-3F show different arrangements of zip fastener teeth with respect to conducting and insulating property; and

FIG. 4 shows a part of a zip fastener connector.

Description of Preferred Embodiments

FIG. 1 is a schematic illustration (not to scale) of a first embodiment of a zip fastener (or zipper) connector 1. The zip fastener connector 1 is based on a conventional mechanical zip fastener, and comprises, in common with such conventional zip fasteners, two strips of fabric (of any suitable flexible material, including woven material or plastic etc.) 2, 3, sometimes referred to as tapes. Affixed on the first strip of fabric 2 are teeth 4-12 (also known as elements), forming a first set of teeth. Affixed on the second strip of fabric 3 are teeth 14-22, forming a second set of teeth. Also fixed on the first strip of fabric 1 are a bottom stop 30 and a top stop 32. Also fixed on the second strip of fabric 2 is a top stop 34.

A slider 36 is positioned such that the teeth 4-12, 14-22 pass through the slider 36 and mesh together, i.e. become interlocked, when passing through the slider 36. Optionally, a pull-tab 38 is provided on the slider 36 to facilitate a user sliding the slider over the teeth. The bottom stop 30 and the two end stops 32, 34 prevent the slider from sliding off the last teeth.

Such zip fasteners, their characteristics, their manufacture, and their operation are well known, and the above described parts may in practice take the form of any conventional zip fastener, for example a separating zip fastener instead of the closed bottom zip fastener of FIG. 1, or a zip fastener with two sliders, e.g. one at each end.

In a simple form of this invention, the zip fastener connector 1 provides only one-pole or one-way connection. In this case all the teeth 4-12, 14-22 are made to be electrically conducting, i.e. are made from a metal, e.g. copper, or coated in an electrically conducting material, for example are gold-plated or nickel-plated. Additionally, at least one of the teeth in the first set of teeth, in this example tooth 5, is connected to a conducting lead 40 from one of a pair of items to be electrically connected, and at least one of the teeth from the other set that touches the tooth 5 when the sets are interlocked, in this example tooth 15, is connected to a conducting lead 42 from the other item to be electrically connected.

Thus, in operation, when the zip fastener is interlocked by operation of the slider, the conducting lead 40 is electrically connected to the conducting lead 42. Moreover, if the electrical item from which conducting lead 40 extends is attached to the fabric strip 2, and likewise, the electrical item from which conducting lead 42 extends is attached to the fabric strip 3, then these two items become mechanically fixed together by virtue of the zip fastener connector 1.

In a more complex embodiment, the zip fastener connector 1 may provide multi-way connection, that is a plurality of separate independent (i.e. insulated from each other) electrical connections. One such example is shown in FIG. 1, in that a further connection is made between tooth 11

of the first set of teeth, which is connected to a conducting lead 44 (shown in dotted outline as it is only present in this more complex embodiment), and tooth 21 of the second set of teeth, which is connected to a conducting lead 46 (also shown in dotted outline as it is also only present in this more complex embodiment).

Electrical connection between tooth 11 and tooth 21 is provided by both tooth 11 and tooth 21 being electrically conducting, as per tooth 5 and tooth 15. However, in order to isolate this connection between teeth 11 and 21 from the other connection between teeth 5 and 15, at least one of the teeth from at least one of the sets of teeth 4-12, 14-22 positioned between the two connections is of an electrically insulating form, i.e. is either made from an electrically insulating material, for example nylon, or is coated in such a material.

In this particular example, all the teeth except for teeth 5, 15, 10 and 21 are made to be insulating, but the layout of conducting compared to insulating teeth may be chosen as required. Also, more than two connections may be provided, and in the case of larger numbers of connections, e.g. 20-way, systematic arrangement of conducting compared to insulating teeth may be selected as required. (Indeed, certain exemplary layouts will be described in more detail below with reference to FIGS. 3A to 3F.)

In each of the above embodiments, the conducting leads may be woven into the respective fabric strips 2 and 3.

The above described zip fastener connector 1 may be employed in any situation requiring an electrical connector, especially where the strong mechanical fixing provided by the zip fastener's mechanical characteristics is useful.

Depending on the items being connected, it may be preferable to connect a zero volts (0V), or other "safe" connection, to those teeth which will form the connection that will be the first connection to be formed when the slider action interlocks the teeth e.g. in the case of FIG. 1, the connection provided by teeth 15 and 5 would be connected to 0V rather than the connection provided by teeth 11 and 21.

In a preferred embodiment, the zip fastener connector 1 is used for connecting two electrical modules that are included in, or readily fixed to, clothing, as in the following example.

FIG. 2A shows a person 50 wearing a jacket 52. The jacket 52 has a lightweight battery driven music player 54 sewn into it, or as an integral part of it. The music player 54 has two conducting leads 56, 58, that extend along the arm portion of the jacket 53 to a first half 60 of a zip fastener of the type described in the second embodiment above. Leads 56 and 58 may run outside the jacket. They may alternatively run either inside the jacket, or inside the material layers of the jacket.

The fabric strip, to which a set of teeth is fixed, is sewn into the material of the jacket 52. The jacket 52 also comprises an optional pouch 62 near the first half of the zip fastener connector.

Also shown in FIG. 2A is an optional display device 64 which may be connected when desired by the user 50 to the music player 54. The display device 64 comprises a second half 66 of a zip fastener connector.

When the user 50 wishes to connect the display device 64 to the music player 54, the user zips the two halves of the zip fastener connector together using a slider (not shown) thereby interlocking the teeth in conventional zip fastener manner.

FIG. 2B shows the resulting state, with the display device 64 connected to the leads 56, 58 of the music player 54 by means of the zip fastener connector's two halves 60, 66 being interlocked, thereby completing the zip fastener connector 1. In this example the display device is also placed in the pouch 62, which stops the display device swinging around when the user 50 moves about, but nevertheless the means by which the display device is fundamentally fixed to the jacket 52, i.e. such that it will not fall off even if the arm is swung wildly, is the zip fastener connector.

It will be appreciated that the embodiments shown in FIGS. 1, 2A and 2B are merely exemplary, and a vast number of other implementations are possible. In the case of FIGS.

2A and 2B, any type of clothing may be combined with any type of electrical products requiring to be carried and interconnected. The different modules (e.g. music player, display device etc.) may be built in or attached to clothing or other items (e.g. baggage, straps etc.) in any suitable way, and likewise the leads 56, 58 and other equivalent leads may be implemented as required, e.g. woven into material, attached to the surface, left free, etc.

Alternatively, the display may be an integral part of a sleeve assembly that is zipped on to a sleeveless jacket, possibly in order to replace a conventional sleeve without any electrical items in it.

As mentioned above, different layouts of conducting teeth compared to insulating teeth are possible, as will now be explained in more detail with reference to FIGS. 3A-3F.

FIGS. 3A-3F show different arrangements of teeth with respect to conducting and insulating property. In each case the drawing is schematic to illustrate basic possibilities, and as such are not to scale and do not indicate any limitations as to length, number of connections of a whole connector, etc.

In Figs. 3A-3F, for clarity, the teeth are shown as rectangles rather than barb-shaped. In FIGS. 3A-3C, conducting teeth are shown shaded and insulating teeth are shown clear. Additionally, in FIGS. 3D-3F, conducting

portions of each tooth are shown shaded and insulating portions are shown clear.

FIG. 3A shows one arrangement. In a first set of teeth 101-107, every second tooth 101, 103, 105, 107 is insulating, and the teeth therebetween 102, 104, 106 are each conducting. Likewise, in a second set of teeth 111-117, every second tooth 111, 113, 115, 117 is insulating, and the teeth therebetween 112, 114, 116 are each conducting.

Thus, in the interlocked state shown in FIG. 3A, three separate connections are made by conducting pairs of teeth 102/112, 104/114 and 106/116, each separate connection being electrically isolated from the others by the insulating pairs of teeth 101/111, 103/113, 105/115 and 107/117. This arrangement allows the same manufacturing set-up to be used for both sets of teeth (they are the same as each other) and provides a uniform distribution of connections.

A modification is to have more insulating teeth between each conducting tooth, so providing stronger isolation between the separate connections, or more conducting teeth between insulating teeth to increase current carrying capabilities, or a combination of both modifications.

FIG. 3B shows another arrangement. In a first set of teeth 121-127, every second tooth 121, 123, 125, 127 is insulating, and the teeth therebetween 122, 124, 126 are each conducting. However, in a second set of teeth 131-

137, each tooth 131-137 is conducting. Thus, in the interlocked state shown in FIG. 3B, three separate connections are made by conducting pairs of teeth 132/122/133, 134/124/135 and 136/126/137, each separate connection being electrically isolated from the others by the insulating teeth 121, 123, 125 and 127. This arrangement allows one of the sets of teeth to be manufactured entirely from conducting teeth, as with conventional metal zip fasteners, hence possibly reducing cost.

FIG. 3C shows another arrangement. In a first set of teeth 141-147, the teeth 141, 143 and 147 are insulating, the remaining teeth 142, 144, 145, 146 are conducting. In a second set of teeth 151-157, teeth 151, 153, 155, are insulating, and the teeth 152, 154, 156, 157 are each conducting. Thus, in the interlocked state shown in FIG. 3C, three separate connections are made by conducting groups of teeth 142/152, 144/154 and 145/156/146/157, each separate connection being electrically isolated from the others by the insulating groups of teeth 141/151, 143/153, and single insulating teeth 147,155. This arrangement provides varying size of connection point, i.e. the connection provided by teeth 145/156/146/157 contains more teeth than the other connections. Therefore, it may be used for a higher current carrying connection. The number of teeth so arranged may be selected as required.

The arrangement shown in FIG. 3C may be considered as a modification of the arrangement of FIG. 3A. A similar

modification may be made to the arrangement shown in FIG. 3B.

FIG. 3D shows another arrangement. Each of the teeth comprises a conducting portion (shown shaded) and an insulating portion (shown clear). The relative position of conducting portion to insulating portion is reversed in the second set of teeth (162) compared to the first set of teeth (161). Thus, in the interlocked state shown in FIG. 3D, a separate connection is made from each conducting part of a tooth from the first set (161) with a conducting part of a corresponding tooth of the second set (162). This provides a high density of connections, in that one connection may be provided for each interlocked tooth pair. Also, the same manufacturing process may be employed for both sets of teeth.

FIG. 3E shows another arrangement. In a first set of teeth (171), each of the teeth comprises a conducting portion (shown shaded) and an insulating portion (shown clear). However, the teeth of the second set of teeth (172) are each completely conducting (shown shaded). Thus, in the interlocked state shown in FIG. 3E, a separate connection is made from each conducting part of a tooth from the first set with a corresponding tooth of the second set. This again provides a high density of connections, in that one connection may be provided for each interlocked tooth pair. This arrangement allows one of the sets of teeth to be manufactured entirely from conducting teeth, as with conventional metal zip fasteners, hence possibly reducing cost.

FIG. 3F shows another arrangement. Each of the teeth comprises a central insulating portion (shown clear) with a conducting portion (shown shaded) either side of the insulating portion. Thus, in the interlocked state shown in FIG. 3F, a separate connection is made from each conducting part of a tooth from a first set (181) with a corresponding conducting part of a corresponding tooth of a second set (182). This provides an even higher density of connections than the arrangement of FIG. 3D, in that here two connections may be provided for each interlocked tooth pair. Here, again, the same manufacturing process may be employed for both sets of teeth.

The arrangements shown in FIGS. 3A-3F are simple arrangements showing certain design principles with attendant advantages. More complex designs may be implemented which employ in combination more than one of the above principles.

Another option is to use more than one type of conducting material for different conducting teeth or different conducting portions of conducting teeth. The materials may then be optimized according to the application of the connector, and particularly with respect to different applications (e.g. power compared to data) for different connections being made, e.g. some gold plated, some silver plated.

Referring again to FIGS. 2A and 2B, another option is available when a plurality of different items can be

selected for connection to a given item, e.g. when either the display device 64 or an additional speaker (not shown) may be connected. In order to allow different connections to be made depending on which of the possible items is connected, the different items, e.g. the display device 64 and the speaker are provided with different arrangements of conducting and insulating teeth. In this manner, differing connections can be made by either item when connected to the single, jointly serving first half 60 of the zip fastener connector. In this case, two further leads (also not shown) may be provided in the jacket 52 from the music player 54 to the connector half 60 for connection with the speaker.

The above-described embodiments may be employed for connecting together two printed circuit boards. However, another embodiment will now be described that is particularly suited for connecting together two printed circuit boards. FIG. 4 shows a part of such a zip fastener connector according to this embodiment.

In figure 4, a first flexible tape 401 is fixed to one edge of a first printed circuit board 403. On this first tape 401 is affixed a first set of zip fastener teeth 410-416, of the physical form shown in the drawing. A second flexible tape 405 is fixed to one edge of a second printed circuit board 407. On this second tape 405 is affixed a second set of zip fastener teeth 420-427, again of the physical form shown in the drawing. The following teeth are insulating: 411, 414, 420, 423, and 426. The other

teeth, i.e. 410, 412, 413, 415, 416, 421, 422, 424, 425, and 427 are conducting.

Each of the conducting teeth 410, 412, 413, 415, 416, 421, 422, 424, 425, and 427 has a corresponding connection 430, 432, 433, 435, 436, 441, 442, 444, 445, and 447 from the printed circuit board brought to it and coupled thereto. When the teeth are interlocked by the action of a slider (not shown) consecutive pairs of interlocked teeth make up respective separate electrical connections with an insulating tooth between each consecutive connection pair providing isolation.

The angle of fixing between the printed circuit board 403 and the printed circuit board 407 may be selected as required, i.e. it need not be flat.

Although particularly suited to providing edge connection for printed circuit boards, especially flexible circuit boards, this embodiment may be employed for other edge connection applications.

It will be appreciated that FIG. 4 is not drawn to scale. Therefore, although some degree of flexibility is required for the printed circuit boards to move from their unconnected position to their connected position, the extent of such flexibility/movement is shown as exaggerated in FIG. 4. Depending on printed circuit board sizes and thickness, even printed circuit boards not normally considered as flexible circuit boards per se may nevertheless have a small amount of flexibility that

proves sufficient to allow connection to be implemented with a zip type connector of the types described above.

It will be understood that the invention as exemplified in the above-described embodiments tends to provide the following advantages, either singly or in combination:

(i) it provides automatic and repeatable registration of electrically connecting 'pairs';

(ii) it can provide a high connector density;

(iii) it is of a physical form that will be readily accepted by consumers;

(iv) it will remain physically flexible, unlike a conventional multiway connector;

(v) low insertion force is required for making the connection, compared to many conventional electrical connectors, particularly as the number of connections is large, as in conventional connectors the overall insertion force is accumulative, whereas with the zip fastener connector each connection is made separately in time as the slider moves along the teeth;

(vi) the rubbing movement as the teeth are brought into contact with each other can provide a self-cleaning effect;

(vii) it can be designed for different current carrying capacities, connector densities or a mixture of both;

(viii) The tooth size of the zip can be optimised depending on the application and overall current carrying requirements;

(ix) It is robust and easy to use;

(x) Zip fastener technology is mature, and materials (conducting and insulating) are known to be long lasting and to withstand everyday activities such as machine washing; and

(xi) It is particularly convenient for clothing-borne devices, also for printed circuit boards.

In summary, a method of electrically connecting items has been described. The method includes the steps of electrically connecting a first item to one or more teeth of a first set of teeth of a zip fastener; and electrically connecting a second item to one or more teeth of a second set of teeth of the zip fastener. The first set of teeth are placed in electrical contact with the second set of teeth by interlocking the two sets of teeth using a slider of the zip fastener.

Furthermore, a method of connecting and fixing together printed circuit boards has been described.

Additionally, a method of attaching electrical equipment to clothing and making electrical connections therefor has been described.

A portable electrical apparatus has been described that includes clothing; electrical modules positioned in the clothing; and one or more zip fasteners arranged to electrically connect the electrical modules.

In addition, an electrical apparatus has been described that includes an electrical connector. The connector includes a set of zip fastener teeth for interlocking and thereby making electrical connection with a mating set of zip fastener teeth of a mating connector.

Furthermore, an electrical connector has been described that includes a zip fastener including two sets of interlocking teeth and a slider operable to bring the teeth into an interlocked state. In one of the sets, at least some of the teeth have at least a portion that is electrically conducting and at least some of the teeth have at least a portion that is electrically insulating. In the other of the sets, at least some of the teeth have at least a portion that is electrically insulating, such that when the teeth are interlocked a plurality of separate electrical connections are formed by respective groups of teeth, each of the respective groups of teeth comprising at least one tooth from each of the sets of teeth.

Claims

1. A method of electrically connecting items, the method being characterised by:

electrically connecting a first item (54) to one or more teeth of a first set (60) of teeth of a zip fastener;

electrically connecting a second item (64) to one or more teeth of a second set (66) of teeth of the zip fastener; and

placing the first set (60) of teeth in electrical contact with the second set (66) of teeth, by interlocking the two sets of teeth using a slider of the zip fastener.

2. A method according to claim 1, wherein the step of interlocking the two sets of teeth using the slider of the zip fastener includes the step of:

fastening the first item (54) to the second item (64).

3. A method according to claim 1 or 2, the method further characterised by the step of:

forming a plurality of separate connections along the zip fastener by use of both conducting and insulating material for the teeth of the zip fastener.

4. A method according to claim 3, the method further characterised by the step of:

allocating a 0 volts connection to the teeth of the zip fastener which are first to be joined by operation of the slider.

5. A method according to claim 3 or 4, wherein different items are provided with different arrangements of conducting and insulating teeth so that differing connections are made by different items when connected to a given set of teeth connected to a given item.

6. A method of connecting and fixing together printed circuit boards (403, 407) comprising using the method of any of claims 1 to 5.

7. A method of attaching electrical equipment to clothing and making electrical connections therefor comprising using the method of any of claims 1 to 5.

8. Portable electrical apparatus, comprising:

clothing; and

electrical modules positioned in the clothing; characterised by:

one or more zip fasteners arranged to electrically connect the electrical modules.

9. Apparatus according to claim 8, wherein a first electrical module (54) is connected to one or more teeth of a first set (60) of teeth of the zip fastener (1);

a second electrical module (64) is connected to one or more teeth of a second set (66) of teeth of the zip fastener (1); and in operation electrical connection is made between the first and second electrical modules by the first set of teeth being placed in electrical contact with the second set of teeth by interlocking the two sets of teeth using a slider of the zip fastener.

10. Apparatus according to claim 9, wherein the first and/or second module is connected respectively to the one or more teeth of the first and/or second set of teeth by connecting leads woven into fabric of the clothing and/or the zip fastener (1).

11. Electrical apparatus, comprising an electrical connector, characterised by the connector comprising a set of zip fastener teeth for interlocking and thereby making electrical connection with a mating set of zip fastener teeth of a mating connector.

12. An electrical connector, comprising:

a zip fastener (1) comprising two sets of interlocking teeth (4-12, 14-22) and a slider (36) operable to bring the teeth (4-12, 14-22) into an interlocked state; characterised in that:

in one of the sets at least some of the teeth have at least a portion that is electrically conducting and at least some of the teeth have at least a portion that is electrically insulating, and in the other of the sets at least some of the teeth have at least a portion that is electrically insulating, such that when the teeth are interlocked a plurality of separate electrical connections are formed by respective groups of teeth (5 and 15; 11 and 21), each of the respective groups of teeth comprising at least one tooth from each of the sets of teeth.

13. An electrical connector according to claim 12, wherein at least the exterior of each of the teeth is either completely of electrically conducting material, thereby providing a conducting tooth, or completely of insulating material, thereby providing an insulating tooth, and the conducting teeth are arranged relative to the insulating teeth such as to provide the plurality of separate electrical connections formed when the teeth are interlocked.

14. An electrical connector according to claim 12, wherein some of the teeth comprise an electrically conducting portion and an electrically insulating portion, and the teeth are arranged so as to provide the plurality of separate electrical connections formed when the teeth are interlocked.

15. An electrical connector according to any of claims 12 to 14, further comprising electrically conducting leads woven in to the fabric part of the zip fastener and connected to teeth of the zip fastener.

16. An electrical connector according to any of claims 12 to 15, wherein the slider (36) is of electrically insulating material.

17. A method of electrically connecting items substantially as hereinbefore described with reference to the accompanying drawings.

18. An electrical connector substantially as hereinbefore described with reference to the accompanying drawings.

**Application No:** GB 0117779.9
**Claims searched:** 1 - 18

**Examiner:** Paul Nicholls
**Date of search:** 30 October 2001

# Patents Act 1977
# Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S):

Int Cl (Ed.7):

Other: Online: WPI, EPODOC, JAPIO

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | DE 200 14 929 U1 | (STREETMANN) - See whole document | 1-4, 7-12, 15, 16 |
| X | FR 2 561 452 A1 | (SAUVAGE) - See whole document | 1-4, 11 |
| X | US 5,499,927 A | (OHNO et al) - See figure 1 | 1-4, 6, 11, 12, 14, 16 |
| X | US 4,931,021 A | (MOHAN) - See figures 1 and 3 | 1-4, 6, 11-14, 16 |

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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